

# Experiments with Tropical Cyclone Wave and Intensity Forecasts

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## LONG-TERM GOALS

The goal of this project is to improve guidance for the prediction of waves and intensity associated with tropical cyclones.

## OBJECTIVES

The objectives of this project are to develop, test and evaluate new strategies to predict (a) tropical cyclone generated waves and (b) tropical cyclone intensity as measured by one-minute mean maximum sustained wind speed.

## APPROACH

(1) Develop a strategy to forecast waves that are consistent with tropical cyclone warnings/advisories from the Joint Typhoon Warning Center and the National Hurricane Center. Evaluate results against available buoys or other observations. The wave forecast algorithm must be designed to operate within the constraints of the Fleet Numerical Meteorology and Oceanography Center infrastructure and must be efficient in that the products can be made available to users within six hours of the warning/advisory dissemination. (2) Attempt to improve intensity forecasts from the Statistical Typhoon Intensity Prediction System (STIPS) and other forecast models. Implement and experiment with new formulations of STIPS. Publish results.

## WORK COMPLETED

### *1. Wave forecast algorithm*

In FY07, we designed and implemented a version of Wavewatch III that uses tropical cyclone warnings/advisories as input. Much of the emphasis was designing the infrastructure for an algorithm that could produce forecasts for all tropical cyclones in the Northern Hemisphere.

### *2. Intensity forecast algorithm.*

In FY07, we experimented with intensity consensus combinations for the Atlantic, eastern and western North Pacific basins. These experiments were documented in a Note to Weather and Forecasting.

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## RESULTS

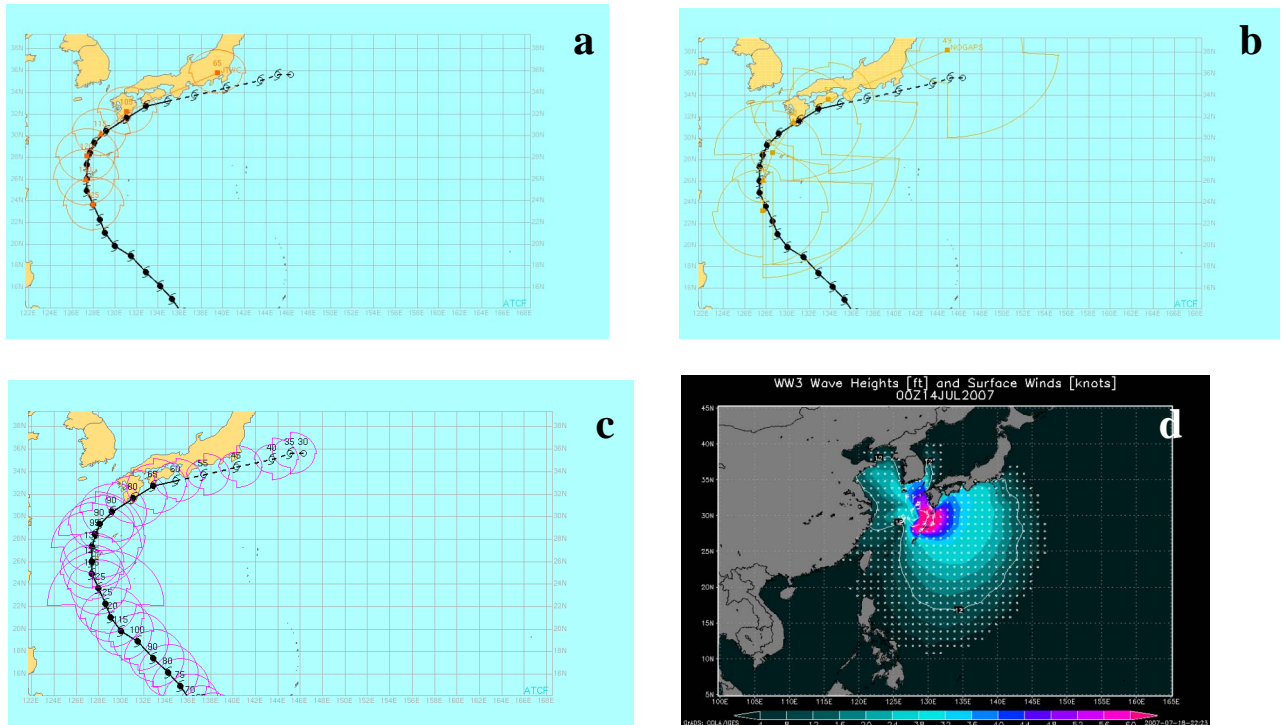
### *1. Wave forecast algorithm*

So far, the results from testing have been anecdotal. Figure 1 shows a JTWC forecast (track and 34 kt wind radii), the concurrent NOGAPS forecast, and the verifying best track for MAN-YI (WP042007). The JTWC and NOGAPS forecasts from 12 UTC on July 12, 2007 both show MAN-YI moving north into Kyushu. In this particular case, the JTWC and NOGAPS forecast tracks are similar with the NOGAPS forecast hitting Kyushu about six hours early and the JTWC forecast hitting about six hours late. The JTWC intensity forecasts (not shown) are 5-25 kt too high in the 36 hours before MAN-YI runs ashore while the NOGAPS forecast are 38-79 kt too low. The JTWC 34 kt wind radii (Fig. 1a) are generally smaller than the verifying wind radii (Fig. 1c) by 0-100 nm, and the NOGAPS 34 kt wind radii (Fig. 1b) are generally larger than the verifying 34 kt wind radii, especially in the SE quadrant where the errors approach 400 nm.

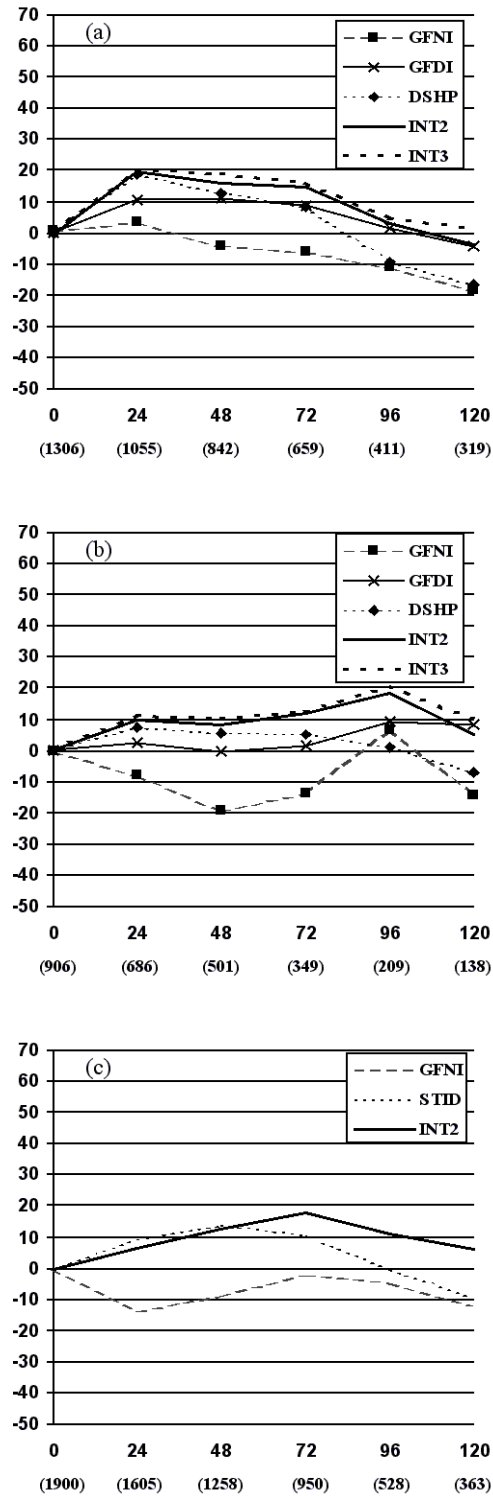
The 36-h Wavewatch III forecast using the JTWC warning as input is shown in Fig. 1d. This was just as the JTWC forecast was moving MAN-YI into Kyushu. Significant wave heights were forecast to approach 60 feet just offshore of Kyushu. Since the JTWC forecast intensity was 5-25 kt higher than observed, we suspect that the forecast significant wave heights are also high. We also suspect that using 10-minute mean winds as input to Wavewatch III may be more appropriate than using 1-minute mean winds. In future work, we intend to use buoys and altimeter passes to verify the results and test the system more rigorously.

### *2. Intensity forecast algorithm.*

In this work, we found that forming a consensus (average) of the most skillful model forecasts produces forecasts with mean forecast errors that are generally lower than the individual model errors. Figure 3 shows skill relative to a statistical forecast aid for the individual aids and consensus aids for the Atlantic, eastern North Pacific and western North Pacific basins. The skill of the consensus aids (INT2 and INT3) is generally higher than individual model skill, and some of the differences are highly significant (using a one-tailed t-test that accounts for 30 hours of serial correlation). These consensus aids are now undergoing operational evaluation at the forecast centers for use as baselines to verify other more complex ensemble techniques and as forecast aids for use in real-time forecasting.



**Figure 1. Track and 34 kt wind radii for a) the JTWC forecast b) the NOGAPS forecast, c) the verifying tropical cyclone analysis and d) resultant 36-h Wavewatch III forecast using JTWC forecast as input. Forecasts are for MAN-YI (WP052007) 12 UTC July 12, 2007.**



**Figure 2. Intensity forecast skill (%) of consensus and consensus members relative to a statistical model in (a) the Atlantic, (b) the eastern North Pacific, and (c) the western North Pacific for the 2003-2006 seasons. INT2 and INT3 are the consensus aids while GFDI, GFNI, DSHP and STID are individual forecast aids.**

## **IMPACT/APPLICATIONS**

The Wavewatch III work is intended to be a forecast aid for ship routing and shore sites with assets affected by high seas. The output is consistent with the operational tropical cyclone forecast, which can be much different than that of an individual NWP model. The concept has received interest and encouragement from Naval personnel at NMFC Pearl Harbor, NMFC Norfolk, COMSUBGRUSEVEN Japan, TPC Miami and NOAA/NWS WFO Honolulu.

The intensity consensus aids produce deterministic forecasts that are intended for use at the Joint Typhoon Warning Center and the National Hurricane Center. Intended uses are for operational guidance and as baselines to evaluate the skill (in terms of mean forecast error) of other more complex ensemble techniques. The aids developed in this work are currently undergoing operational evaluation.

## **TRANSITIONS**

The Wavewatch III work transitions to 6.4 ATCF and then to Fleet Numerical Meteorology and Oceanography Center.

The intensity consensus transitions to 6.4 ATCF then to the Joint Typhoon Warning Center and the National Hurricane Center.

## **RELATED PROJECTS**

None.

## **REFERENCES**

None

## **PUBLICATIONS**

Sampson, C. R., J. L. Franklin, J. A. Knaff and M. DeMaria, 2007: Experiments with a Simple Tropical Cyclone Intensity Consensus. Wea. And Forecasting, In Press.